from line PT to line PR, and thence through centre C upon line PR′. Moreover, the point P is the point of intersection of lines PT′ and PR′; wherefore, by Theorem I., the lines PT′ and PR′ are in perspective.

In order to find the centre of perspectivity of lines PT′ and PR′, we have the point k on line PT correlative of the point at infinity on PT′, k being determined by drawing Bk parallel to PT′. The point k_1' on PR′, correlative of k on PT, is found as before by projecting k first upon PR in k' and thence upon PR′ in k_1'. Thus, the required centre of perspectivity must lie somewhere on the indefinite line joining k_1' with the point at infinity upon PT′. Again, the point i' on PR corresponds to the point at infinity on PR′, to point i on PT, and to point i_1 on PT′; hence the sought centre must lie somewhere on the indefinite line joining i_1 to the point at infinity on PR′; wherefore it coincides with the intersection of lines i_1S and k_1'S.

Similarly it can be shown that the lines PT and PR′ are in perspective; for the line drawn from C, the centre of projection for line PR′, to S_∞, the centre of projection for line PT, or, in other words, the line drawn from C parallel to dd', ee', &c., is a coharmonic ray common to both lines; therefore, according to Theorem II., the lines PT and PR′ are in perspective. The corresponding centre of perspectivity is determined as follows. When the line oo', moving parallel to itself, passes to infinity, or, in other terms, when the points o and o' pass to infinity on lines PT and PR, the ray Co' takes up the position CF, parallel to PR. Hence, F is the point on line PR′ corresponding to infinity on PT; wherefore the required centre must lie somewhere on the line through F parallel to PT. But i is the point on PT corresponding to infinity on PR′; therefore the centre must lie somewhere on the line through i parallel to PR′. Hence we conclude that it must coincide with the point of intersection of lines FG and iG.

In this short paper we have made an honest attempt to trace one filament of the great stream of modern science to its original source. The space at our service may not admit of much more. Still, such a study, however limited its scope may be, is interesting, not only on account of the novel nature of the demonstrations which the proof of connection involves, but even more because of the reflex light thus cast upon recent invention.

Robert H. Graham.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—The Observatory Syndicate Report as follows:—

That they have considered the proposal made in the Report of the Newall Telescope Syndicate for the purchase of an acre or an acre and a half of land adjoining the grounds of the Observatory for the erection of the Newall telescope and its appurtenances, and they are of opinion that, in view of possible future requirements of the Observatory, it will be desirable to secure now the larger area—namely, an acre and a half.

They have consulted the Bursar of St. John's College, and have learnt that the College is willing to sell to the University an acre and a half at the price of £250. Further, Prof. Adams has offered to contribute £100 towards expenses.

Under these circumstances the Syndicate recommend that Prof. Adams's generous offer be accepted, and that the Vice-Chancellor, on behalf of the University, be empowered to enter into an agreement with St. John's College for the purchase of an acre and a half of land adjoining the grounds of the Observatory.

SOCIETIES AND ACADEMIES.

London.

Royal Society, May 1.—"Photographic Determination of the Time-relations of the Changes which take place in Muscle during the Period of so-called 'Latent Stimulation.'" By J. Burdon Sanderson, F.R.S.

It is now forty years since Helmholtz published his fundamental experiments on the time-relations of muscular contractions. The purpose of this investigation was to ascertain "the periods and stages in which the energy of muscle rises and sinks after instantaneous stimulation"; the word energy being defined as the "mechanical expression of activity"; and one of the most important conclusions of the author was that, in the muscles investigated by him, contraction does not begin until nearly one hundredth of a second after excitation. This interval has, by subsequent writers, been called the period of "latent stimulation."

Helmholtz subsequently (1854) showed, by experiments of surpassing ingenuity, that during this period an electrical change of very short duration occurs, which culminates at about one two-hundredth of a second after excitation. The fact discovered by Helmholtz was further investigated by Bernstein in 1866, with the aid of the repeating rheotome, and subsequently (1875) by du Bois-Reymond, whose statement of the actual time-relations of the electrical response to an instantaneous excitation of the gastrocnemius of the frog is embodied in a curve which denotes that the muscular surface becomes negative to the tendon about three thousandths of a second after excitation, that this effect culminates at seven thousandths of a second, and that it is immediately followed by a change of opposite sign, which culminates at about ten thousandths.

By a new method—that of photographing in succession the mechanical and electrical responses in muscle on a rapidly moving sensitive surface—the author has shown that the mechanical response occurs much earlier than has been hitherto supposed; and that it is, in fact, simultaneous with the electrical change above described—that is, with the so-called negative variation.

The method consists in projecting the movement to be recorded, whether of the muscle or that of any instrument which serves as an index of change, on a vertical slit on which the vibrations of a tuning-fork and the motion of a signal are also shadowed. Immediately behind the slit is a photographic plate, which is carried by an equilibrated pendulum. The approximately uniform rate of motion of the sensitive surface which receives the light-written record is about one metre per second, but is determined in each experiment by reference to the rate of vibration of a tuning-fork.

In the experiments on direct excitation, the muscles used were the *gastrocnemius* and *sartorius* of the frog. In the former the movement of contraction was communicated to a light index, which was supported by a fine spring. One end of the index rested on the muscle, while the other occupied the front focus of a projection apparatus, the slit being in the other focus. When the sartorius was used the surface of the muscle was itself brought for a moment into the focus, at the seat of excitation. The unavoidable exposure of the structure to the electric light, which this method involved, lasted scarcely more than a second. In successful experiments, the interval between excitation and the beginning of the contraction was $2\frac{1}{2}$ thousandths ($= \frac{1}{400}$) of a second.

For measurement of the delay in indirect excitation, the gastrocnemius (with the index) only was used, the exciting electrodes being applied either at 12 or at 37 mm. from the muscle. The results were not so constant. Corrected for loss of time by propagation along the nerve, the intervals between excitation and beginning contraction varied from 0·0025″ to 0·0035″.

In the experiments for determining the time after excitation at which the electrical response begins and culminates, the capillary electrometer was used, as in the author's experiments on the heart and on the leaf of *Dionæa*, as a signal, but with much improved apparatus for recording.

In the gastrocnemius of the frog, the electrical response to an instantaneous stimulus is indicated by a sudden movement of the mercurial column of so short a duration, that to most persons it is invisible. Its photographic expression is that of a spike projecting from the dark border of the part of the plate which is unprotected by the mercurial column. The electrical interpretation of this spike is that between the contacts two electrical changes of opposite sign and not more than one two-hundredth of a second in duration have immediately followed each other, or, more explicity, that the spot excited became, for about 0·0005″, first negative, then for a similar period positive, to the other contact.

In the muscle (the leading off contacts being on the Achilles tendon and muscular surface respectively, and the nerve excited at a distance of 12 mm.) the electrical response begins at 0·004″ and culminates at about 0·012″ after excitation. Deducting the delay due to transmission along the nerve, we have, as the time between excitation and response, 0·0035″. It is thus seen that the electrical response, instead of preceding the mechanical, is contemporary with it. The electrical change *may* therefore so far as concerns the time at which it occurs in muscle, be immediately connected with that sudden change of the elastic properties of muscle of which the contraction is the sign.

The author exhibited at the Society photographs in proof of all the facts above stated. Further details, particularly those relating to the character of the "electrical response" to instantaneous stimulation, for which the photographic method of recording the movements of the capillary electrometer on a rapidly moving surface has afforded new facilities, will be the subject of a later communication.

Anthropological Institute, May 13.—Dr. J. G. Garson, Vice-President, in the chair.—Mr. Francis Galton exhibited a new instrument for measuring the rate of movement of the various limbs. The method adopted was explained by referring to the action of a spring measuring-tape. When the end of one of these is pulled out and then let go, it springs sharply back, the tape running cleanly through a slit. If it runs back more quickly than the hand could follow it, then, if the end of the tape be retained in the hand that gives the blow, the tape will run through the slit at the exact rate at which the blow is given. The hand need not be near the tape; it may be connected with it by a long thread, and the instrument will thus be guarded from injury. The thread, during part of its course, is arranged to travel vertically, and passes through a small inverted cone which is fixed to it; it then passes loosely through a cylindrical bead of white ivory, the lower end of which rests on the base of the cone. When the moving thread is suddenly arrested, the bead is tossed up to a height dependent on the velocity of the thread at the time and place when it was stopped. The momentary pause of the white bead when it ceases to ascend, and before it begins to descend, enables the height it has attained to be read off upon an appropriate scale, which tells at how many feet per second the thread was moving at the time it was checked.—Dr. G. W. Leitner read a paper on the ethnographical basis of language, with special reference to the customs and language of Hunza. The Hunzas are nominal Mohammedans, and they use their mosques for drinking and dancing assemblies. There is little restriction in the relation of the sexes, and the management of the State, in theory, is attributed to fairies. No war is undertaken unless the fairy gives the command by beating the sacred drum. The people are not true Mohammedans, but represent what is still left of the doctrine of the Sheik-ul-Jabl, or the Ancient of the Mountain, the head of the so-called Assassins. The language of the Hunzas is one of the most primitive, and has not yet emerged from the state in which it is impossible to have such a word as "head," as distinguished from "my head," or "thy head, or "his head;" for instance, *ak* is "my name," and *ik* is "his name." Take away the pronominal sign, and *k* alone is left, which means nothing. *Aus* is "my wife," and *gus* "thy wife." The *s* alone has no meaning, and in some cases it seemed impossible to arrive at putting anything down correctly; but so it is in the initial stage of a language. In the Hunza language that stage is important to us as members of the Aryan group, as the dissociation of the pronoun, verb, adverb, and conjunction from the act or substance only occurs when the language emerges beyond the stage when the groping, as it were, of the human child between the *meum* and *tuum*, the first and second persons, approaches the clear perception of the outer world, the *suum*, the third person.—Mr. A. P. Goodwin read some notes on the natives of the interior of New Guinea, and exhibited a fire-stick.—Mr. G. F. Lawrence exhibited two crania from the Thames.

Geological Society, May 21.—Dr. A. Geikie, F.R.S., President, in the chair.—The following communications were read:—On some Devonian and Silurian Ostracoda from North America, France, and the Bosphorus, by Prof. T. Rupert Jones, F.R.S. After the reading of this paper Dr. Hinde said he wished to express the obligations of geologists to Prof. Jones for the excellent work which he had done amongst the Entomostraca; and particularly on the present occasion, for the clear manner in which he had explained the wide distribution of some of the species. The President alluded to the long years of arduous labour which Prof. Jones had bestowed on these minute fossils, and to the interesting results he had obtained from them.—On the age, composition, and structure of the plateau-gravels of East Berkshire and West Surrey, by the Rev. Dr. A. Irving.—Further note on the existence of Triassic rocks in the English Channel off the coast of Cornwall, by R. N. Worth.—On a new species of *Coccodus* (*C. Lindströmi*, Davis), by J. W. Davis.

Paris

Academy of Sciences, May 27.—M. Hermite in the chair.—Note on the works of M. Louis Soret, by M. A. Cornu.—On the recent work done in Algeria, by M. J. Janssen (see Our Astronomical Column).—On meteorological observations made at mountain stations in Europe and the United States, by M. H. Faye. The author discusses some observations of temperature at various altitudes during cyclones and anticyclones, and the conclusions arrived at by M. Hann at Vienna, and Prof. Hazen in the United States, with respect to the variations found.—On the Turonian flora of Martigues (Bouches-du-Rhône), by M. A. F. Marion.—On the automatic resolution and integration of equations, by M. H. Parenty. An extract of a memoir presented by the author is given.—On the nutation of the axis of the earth, by M. Folie.—On the theory of heat, by M. Appell.—On the elliptical double refraction of quartz, by M. F. Beaulard.—On the conductivities of compounds of ammonia and aniline with the oxybenzoic acids, by M. Daniel Berthelot. One circumstance worthy of attention is that, in spite of the difference of conductivities of the three oxybenzoic acids, the conductivity of the mixture of equivalent parts of each acid and ammonia is almost the same for the three isomerides as for benzoic acid. The author has previously called attention to a similar fact in the case of salts of sodium. It is also noted that the conductivities of ammonium salts are superior to those of the corresponding salts of sodium.—Experiments on magnetization by single and double touch, by M. C. Decharme.—Researches on the dispersion of organic compounds (alcohols of the fatty series), by MM. Ph. Barbier and L. Roux. The authors show—(1) In the alcohols of the fatty series that they have examined, the dispersive powers are continuous functions of the molecular weights, and, contrary to what occurs in the aromatic series, *the dispersive powers increase with increase of molecular weight*. (2) The long-chain isomeric alcohols, primary and secondary, have sensibly the same dispersive power and obey the same laws; but the primary alcohols studied, other than normal, possess less dispersive powers, without, however, departing far from the values shown by long-chain alcohols. (3) The abstraction of hydrogen is accompanied by a considerable increase in the dispersive power.—M. Ed. Grimaux discusses the formula and reactions of homofluorescein.—On the employment of artificial sea-water for the preservation of marine animals, particularly oysters, in great aquaria, by M. Edmond Perrier. The solution recommended contains 81 grams sodium chloride, 7 grams magnesium sulphate, 10 grams magnesium chloride, and 2 grams potassium chloride, dissolved in 3 or 4 litres of water.—Observations on submarine vision, made in the Mediterranean by means of a diving apparatus, by M. H. Fol.—Two new hermaphrodite *Pélécypodes*, by M. Paul Pelseneer.—On the chemical examination of mineral waters from Malaysia; the formation of tin ore, note by M. Stanislas Meunier. An incrustation from the hot spring of Azer-Panas possesses the following composition: SiO_2, 91·8; H_2O, 7·5; **SnO_2, 0·5**; Fe_2O_3, 0·2; and traces of alumina. This is the first instance of the present formation of a tin-ore.—Observations on the structure of some ferruginous deposits of the Secondary rocks, by M. Bourgeat.—Discovery of a Turonian flora in the neighbourhood of Martigues (Bouches-du-Rhône), by M. G. Vasseur.—On the employment of copper salts as a remedy for the potato-disease, by M. Aimé Girard. The author demonstrates that a solution of sulphate of copper used as a preventive of the disease is very efficacious, and results in a gain in the quantity of the crop such as more than pays for the expense of treatment. Even when used purely as a curative agent, the yield of healthy potatoes is increased by 20·2 to 22·9 per cent.

Berlin.

Meteorological Society, May 5.—Prof. Schwalbe, President, in the chair.—Dr. Kiewel spoke on the diurnal periodicity of the wind with special reference to Dr. Sprung's theory of the rotation of its direction. It appeared from his investigation that in addition to the influence of the sun's radiation, the variations of barometric pressure also produce a distinct effect, as also does the difference in the rate of the wind in the upper and lower layers of the atmosphere. A discussion followed, in which Dr.

Sprung took part.—Dr. Wagner announced that arrangements had been made for endeavouring to take simultaneous photographs of flashes of lightning at widely separated stations during the approaching summer. It was hoped that by this means, if successful, it would be possible to obtain some idea of the spacial and dimensional relations of the flash.

Physical Society, May 16.—Prof. du Bois-Reymond, President, in the chair.—Dr. Köpsel exhibited and described an apparatus for the calibration of the torsion-galvanometer of Siemens and Halske. The magnet which is used in that form of the galvanometer which is employed for technical purposes, frequently changes its magnetism in presence of other powerful magnets or currents, hence the instrument requires constant calibration and adjustment. Dr. Köpsel explained his method of effecting this with the help of a Clarke element. He further described a new form of resistance to be used in the measurement of very powerful electric currents. The older form, consisting of a brass tube filled with water, in communication with a reservoir of water, had proved useless in practice. The new resistances consist of nickel wires, surrounded by an insulating layer, inserted into a tube of lead and immersed in water. These wires were not rendered incandescent by currents of 80 to 90 amperes, and have been proved to be practically useful.

Physiological Society, May 23.—Prof. du Bois-Reymond, President, in the chair.—Prof. Falk gave an account of a case of a man who was found dead, and who must have died suddenly. A *post-mortem* examination showed that all the tissues and organs were in a normal state with the exception of the pancreas, which was infiltrated with blood. This he regarded as the cause of death, although it is as yet impossible to suggest how the lesion leads to death. Rupture of a blood-vessel in the pancreas is of rare occurrence.—Dr. Heymans had recently tested Engelmann's statement that the ureters contain ganglia at their upper and lower ends, but no nerves, employing the ureters of mice. Using gold chloride he observed, with low powers of the microscope, nerve-fibres accompanying the blood-vessels which surround the ureters. After removing the peritoneum and spreading out the excised ureters, he also found fine fibres between the muscle-cells, some of which appeared, under high magnification, to be attached directly to the muscle-cells. He was not able to make out that a nerve-fibril supplies each muscle-cell.—Dr. Bruhns gave an account of his researches on adenin and hypoxanthin, with a view to determining their chemical constitution; in this he has not as yet been more than partially successful. During his researches he came across a compound of adenin and hypoxanthin, whose properties explain many opposing statements of the less recent authors. The silver salts, with picric acid of the above bases, are the ones most suited for discriminating between them. Their salts with mercury are also extremely interesting from a chemical point of view, owing to their close resemblance to the amido-compounds of mercury.—Prof. Zuntz described a modified form of intestinal fistula which he and Dr. Rosenberg had recently applied.

Brussels.

Royal Academy of Sciences, April 3.—M. Stas in the chair.—The following communications were made:—Researches on the volatility of carbon compounds, by M. Louis Henry.—On monocarbon derivatives, by the same author.—Reply to a note by General Liagre relative to M. Ronkar's work "On the Mutual Impulse between the Crust and Interior of the Earth on account of Internal Friction," by M. Folie. The criticism referred to appeared in *Bulletin* No. 3 of this year, and in reply to it M. Folie adduces proofs of diurnal nutation.—On the extent of the curative action of hypnotism: hypnotism applied to alterations of the visual organ, by M. J. Delbœuf, with the collaboration of M. J. P. Null and Dr. Leplat. An extended account is given of the treatment of a patient suffering from an eye-disease which was completely cured by hypnotism.—A new Nematoid of a Galago from the coast of Guinea, by M. P. J. Van Beneden.—Note on the law existing between unit of variation of vapour tension and absolute temperature, by M. P. De Heer.—On the structure of the equatorial bands of Jupiter, by M. F. Terby.—On the thickness of the earth's crust deduced from diurnal nutation, by M. E. Ronkar. From an extended investigation it is concluded that the thickness of the earth's crust does not exceed $\frac{1}{100}$ of the radius.—On the mutual impulse between the crust and interior of the earth on account of internal friction (second note), by the same author.—Experimental methods for determining whether polarized light, of which the plane of polarization is in vibration, exercises any influence on a magnetic field, by M. H. Schoentjes.—Experiments on the absence of bacteria in the ducts of plants, by M. Emile Laurent.

Stockholm.

Royal Academy of Sciences, May 14.—On the discovery of Tertiary volcanic rocks near Lake Dellen in Helsingland and Lake Mien in Smaland, Sweden, by Dr. N. O. Holst and Dr. F. N. Svenonius. Specimens exhibited and commented upon by Baron A. E. Nordenskiöld.—Report on an entomological tour in Norrland and Jemtland, chiefly for the study of the Poduridæ of these countries, by H. Schött.—Some observations on the distribution of the sexes in the galls of *Andricus ramuli*, by Prof. C. Aurivillius.—On the Graptolithidæ of the island of Gotland, by Dr. G. Holm.—On the employment of indefinite determinants within the theory of linear differential equations, by H. von Koch.—Invariant expressions for the generalized substitution of Poincaré, by F. de Brun.—On a generalization of the functions of Klein of the third family, by G. Cassel.—The form of the integrals in linear differential equations, by A. M. Johanson.—Contributions to the knowledge of the Chlorophyceæ of Sweden, by O. F. Andersson.—Helminthological researches from the west coast of Norway, Part I., Cestoda, by Dr. E. Lönnberg.—Some Muriceidæ of the genera Acanthogorgia, Paramuricea, and Echinomuricea in the Zoological Museum of Upsala, by T. Hedlund.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

A Synonymic Catalogue of the Recent Marine Bryozoa: E. C. Jelly (Dulau).—The Colours of Animals: E. B. Poulton (K. Paul).—Rambles and Reveries of a Naturalist: Rev. W. Spiers (C. H. Kelly).—Pond Life; Algæ and Allied Forms: T. S. Smithson (Sonnenschein).—Faune des Vertébrés de la Suisse; Vol. v., Histoire Naturelle des Poissons, 2me. Partie: Dr. V. Fatio (Genève, H. Georg).—Gesammelte Mathematische Abhandlungen, 2 vols: H. A. Schwarz (Berlin, J. Springer).—Hints on Reflecting and Refracting Telescopes, &c., 5th edition: W. H. Thornthwaite (Horne).

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